EUROPEWAVE

MARMOK-Atlantic

Aimar Maeso

Mechanical engineer

IDOM Consulting, Engineering and Architecture

IDOM

This project has received funding from the European Union's Horizon 2020 research and Innovation programme under grant agreement 883751.

Introduction

IDOM Consulting, Engineering and Architecture

- Since 1957
- 4000+ employees
- 40 Offices in 125 countries (Headquarters in Bilbao)
- Employee owned, 700+ partners

MARMOK WEC Technology

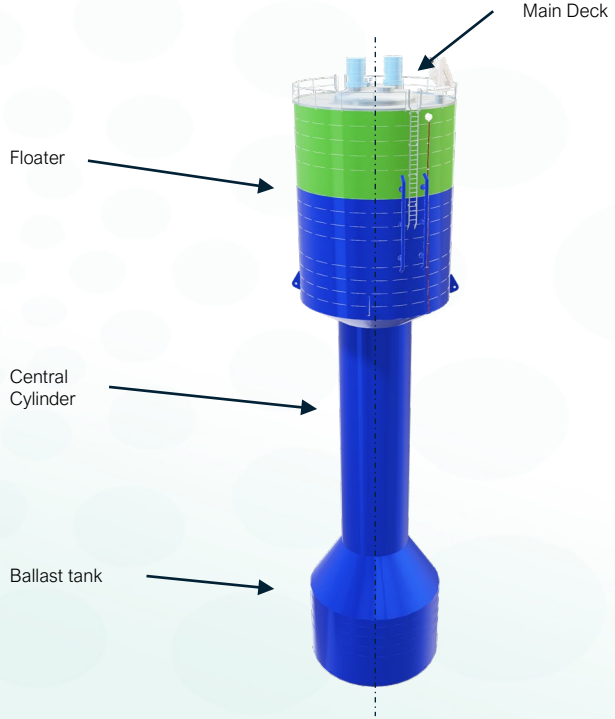
- **13 years experience** in marine renewables. Started with the development of a **Spar type OWC** wave energy converter
- Technology with outstanding **simplicity**, **robustness** and **maintainability** (a single moving part, not submerged)
- **Viability** of the technology **demonstrated** offshore during 2.5+ years (**3 consecutive winters**)

EUROPEWAVE

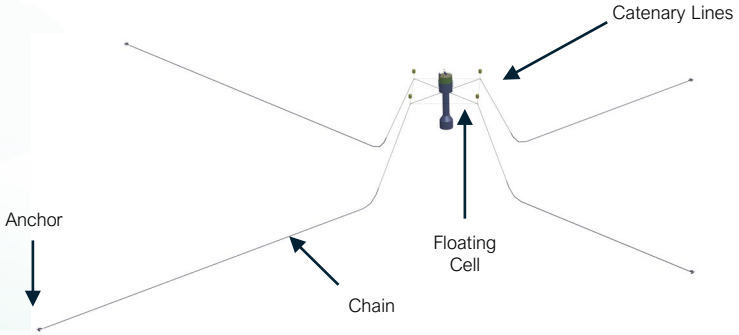
This Project has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement 883751

IDOM

MARMOK Technology



- **Air turbine-electric generator** sets conforming the PTO system
- Number of units and size easily **adaptable** to specific locations
- **Hybrid catenary mooring system** with a submerged floating cell for power performance maximization
- Mooring configuration optimized for **array deployment** with significant cost reductions



EUROPEWAVE

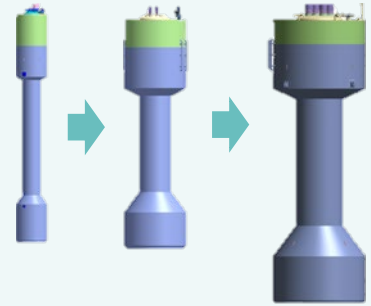
This Project has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement 883751

IDOM

Development paths

MARMOK Technology

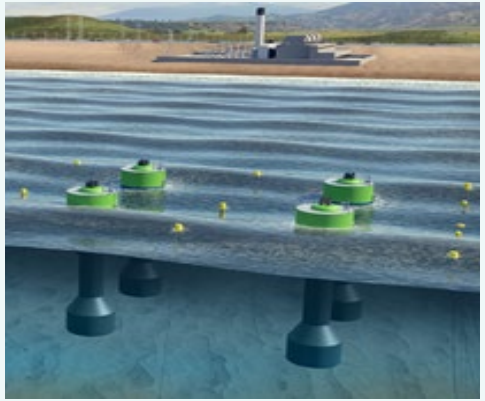
Increase size



Power capture improvement with size

Cost reduction due to component and infrastructure sharing

Increase nº of devices



EUROPEWAVE

This Project has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement 883751

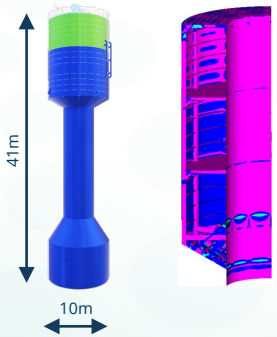
IDOM

Phase 1

Main activities

Geometry optimization

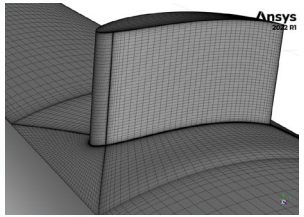
- Optimized for EMEC while compatible with BiMEP



PTO development

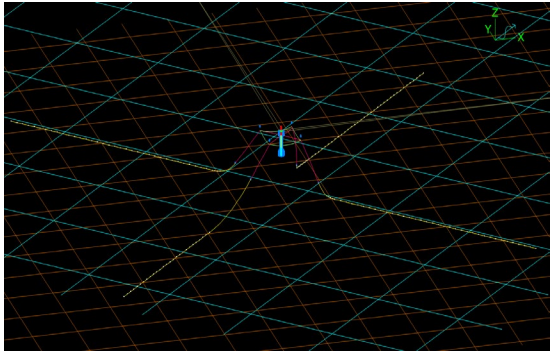
- Aerodynamic tool developed specifically for turbine design to fit in the MARMOK

BEM+GA ⇔ **CFD**



Mooring system design

- Designs developed for BiMEP and EMEC independently due to depth difference



Structural design

- Design capable of enduring extreme conditions in both locations

Control strategy design

- Advanced control strategies developed

Redesigned marine ops

- Minimize divers' involvement

EUROPEWAVE

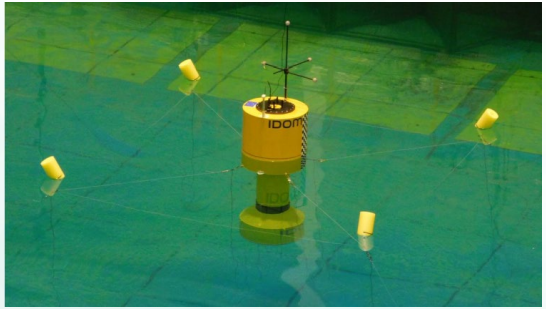
This Project has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement 883751

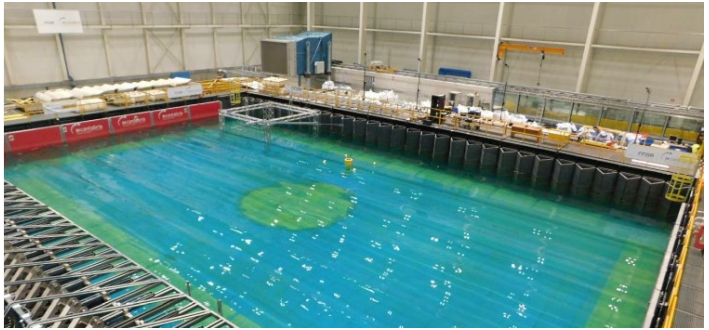
IDOM

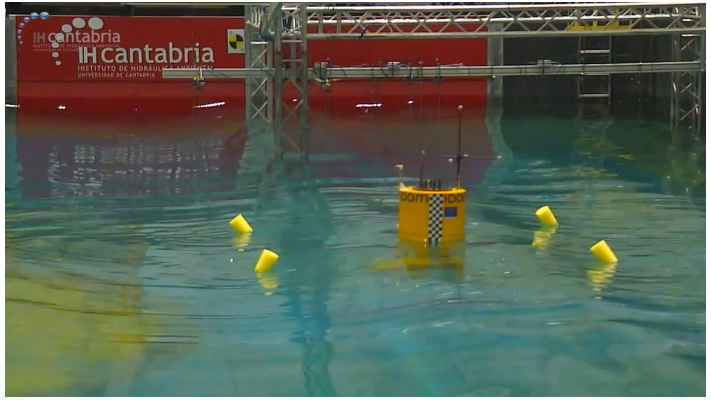
Phase 1

Testing campaign

- Extensive testing campaign conducted in IHCantabria
- 1:23 scale model designed and fabricated in aluminum
- Conducted tests:
  - Decay tests
  - Static offset tests
  - Regular wave tests
  - Long- and short-crested irregular wave tests
  - Survivability tests
  - White noise tests
- Results matched expectations and validation of numerical tools was conducted







EUROPEWAVE

This Project has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement 883751

IDOM

Phase 1

Outcomes

- Versatility of the technology confirmed, designing a device compatible with 2 locations
- Testing campaign:
  - Demonstrated survivability of the system for extreme conditions
  - Power performance expectations confirmed; numerical models reliable for different WEC sizes
  - Successful calibration of numerical models
  - Third party verification of the conducted testing methodology and results
- PTO designing methodology developed and used for analyzing turbine typologies in combination with advanced control strategies showing promising results

Main lessons learnt

- The overall system power performance optimization must include the whole power conversion chain
- Marine ops should be considered from early design stages
- Spar buoy type devices are very sensitive to manufacturing deviations in terms of buoy weight distribution
- While testing, daily data analysis key to identify potential errors
- Prepare data postprocessing tools in advance to allow early data analysis

EUROPEWAVE

This Project has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement 883751

IDOM

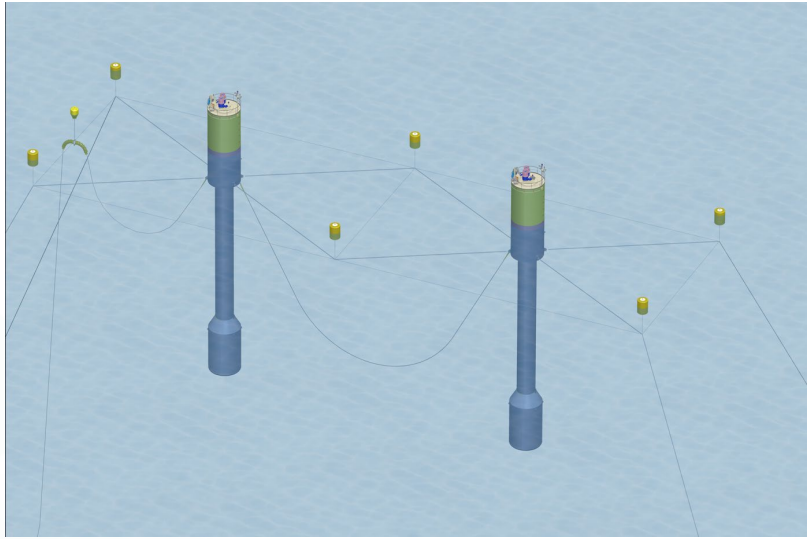
Phase 2

Design consolidation for Phase 3 testing

Decision constrains

- Level of progress with respect to previous deployments
- Representativeness of the platform for innovation demonstration
- Available budget of the project

MARMOK-A-5 array



EUROPEWAVE

This Project has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement 883751

IDOM

Phase 2

Aim: ***"Improve the power performance of the system while maintaining its high robustness, maintainability and reliability"***

Design innovations

Improved PTO

- **Adaptative air turbine** with an improved design
- **Improved electric generator** suited for the application
- Advanced control strategy

Array mooring system

- Design consisting in **two submerged floating cells** sharing one side
- Designed looking for **counterphase movement** of the devices → Mooring Loads reduction

Redesigned operations

- **New operations** design for shared mooring
- Divers' involvement minimization

EUROPEWAVE

This Project has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement 883751

IDOM

Phase 3

AIMS

1. Demonstration of the improved power performance of the overall system achieved through Phase 2 innovation
2. Demonstration of the viability of a shared mooring configuration
3. Confirmation of the high robustness, maintainability and reliability of the technology
4. Demonstration of the optimized marine operations
5. Advance on the pathway for future technology certification

EUROPEWAVE

This Project has received funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement 883751

IDOM

EUROPEWAVE

IDOM

This project has received funding from the European Union's Horizon 2020 research and Innovation programme under grant agreement 883751.